

Wei Ma

CONTACT INFORMATION

Carnegie Mellon University
Department of Civil & Environmental Engineering
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EDUCATION

Carnegie Mellon University, Pittsburgh, PA, USA

Ph.D. candidate, Civil and Environmental Engineering 2014 - 2019 (expected)

- Thesis Topic: *Statistical Inference of Spatial-Temporal Traffic Dynamics through Multisource Data*
- Adviser: Professor Zhen (Sean) Qian

M.S., Machine Learning 2017 - 2018

- Thesis Topic: *An Interpretable Produce Price Forecasting System for Small Farmers in India using Collaborative Filtering and Adaptive Nearest Neighbors*
- Adviser: Professor George H. Chen

M.S., Civil and Environmental Engineering 2014 - 2015

- Thesis Topic: *Generalized Statistical Traffic Assignment (GESTA): Methodology, Properties and Variance Analysis*
- Adviser: Professor Zhen (Sean) Qian

Tsinghua University, Beijing, China

B.S., Pure and Applied Mathematics 2011 - 2014

- Thesis Topic: *Dynamic Parking Prices for Urban Commuters*
- Adviser: Professor Jinxing Xie

B.S., Civil Engineering 2010 - 2014

- *Magna cum Laude*, with honors in engineering
- Thesis Topic: *DynaMIT-based Origin-Destination Estimation using AVI data*
- Adviser: Professor Ruimin Li

RESEARCH INTERESTS

- Intelligent transportation system (ITS)
- Urban systems interdependency
- AI and ML in transportation, infrastructure and energy
- Data-driven and probabilistic network modeling
- Multi-source data mining
- Infrastructure management

HONORS AND AWARDS

- Liang Ji-Dian Fellowship in Carnegie Mellon University, 2018
- Graduate Student Assembly/Provost Conference Funds in Carnegie Mellon University, 2018
- Student of the year, Mobility Data Analytics Center, 2017
- Fenves Travel Grant in Carnegie Mellon University, 2016 & 2017
- College of Engineering Deans Fellowship in Carnegie Mellon University, 2015
- Outstanding Graduates of Tsinghua University, 2014
- First Class Comprehensive Scholarship of Tsinghua University, 2013
- Award for Outstanding Innovation in Civil Engineering Undergraduates in China, 2013
- Excellence of Social Work Scholarship in Tsinghua University, 2013
- The Second Place of Challenge Cup Competition, Tsinghua University, 2012
- Second Place in 18th Structure Design Competition of Tsinghua University, 2012
- Excellence Scholarship of Tsinghua University, 2012 & 2011

PREPRINTS

- [1] **Wei Ma**, Zhen (Sean) Qian, "Measuring and reducing the disequilibrium levels of dynamic networks through ridesourced vehicle data", *Transportation Research Part C: Emerging Technologies*, submitted for review, 2018
- [2] Xidong Pi, **Wei Ma**, Zhen (Sean) Qian, "Multi-modal Dynamic User Equilibrium with Multi-class Vehicles, Ridesharing, Public Transit and Parking", *23rd International Symposium on Transportation and Traffic Theory (ISTTT 23)*, submitted for review (second round), 2018
- [3] **Wei Ma**, Xidong Pi, Zhen (Sean) Qian, "Estimating multi-class dynamic origin-destination demand through a forward-backward algorithm on the computational graph", *The Transportation Research Board (TRB) 98th Annual Meeting*, submitted for review, 2018
- [4] Pengji Zhang, **Wei Ma**, Zhen (Sean) Qian, "Cluster analysis of probabilistic origin-destination demand using day-to-day traffic data", *The Transportation Research Board (TRB) 98th Annual Meeting*, submitted for review, 2018
- [5] Shuguan Yang, **Wei Ma**, Xidong Pi, Zhen (Sean) Qian, "A Deep learning approach of parking occupancy prediction in network-scale incorporating multiple spatio-temporal data sources", *Transportation Research Part C: Emerging Technologies*, submitted for review, 2018
- [6] Xidong Pi, **Wei Ma**, Zhen (Sean) Qian, "Data-driven Mesoscopic Network Modeling With Cars and Trucks: A Case Study in Pittsburgh", *The Transportation Research Board (TRB) 98th Annual Meeting*, submitted for review, 2018
- [7] **Wei Ma**, Zhen (Sean) Qian, "Eliminating Unrealistic Gridlocks in Dynamic Traffic Assignment Models", *Transportation Research Part C: Emerging Technologies*, in preparation, 2018

PEER-REVIEWED
JOURNAL PAPERS

- [8] **Wei Ma**, Zhen (Sean) Qian, "Estimating multi-year 24/7 origin-destination demand using high-granular multi-source traffic data", accepted by *Transportation Research Part C: Emerging Technologies* and forthcoming
- [9] **Wei Ma**, and Zhen (Sean) Qian. "A Generalized Single-Level Formulation for Origin-Destination Estimation under Stochastic User Equilibrium." *Transportation Research Record*, (2018): 0361198118782041. doi:10.1177/0361198118782041
- [10] **Wei Ma**, and Zhen (Sean) Qian. "Statistical inference of probabilistic origin-destination demand using day-to-day traffic data." *Transportation Research Part C: Emerging Technologies*, 88 (2018): 227-256. doi:10.1016/j.trc.2017.12.015
- [11] **Wei Ma**, and Zhen (Sean) Qian. "On the variance of recurrent traffic flow for statistical traffic assignment." *Transportation Research Part C: Emerging Technologies*, 81 (2017): 57-82. doi:10.1016/j.trc.2017.05.009
- [12] Ruimin Li, **Wei Ma** (2010) "Fusion method of road average-speed based on BP neural network and D-S evidence theory", *Journal of Traffic and Transportation Engineering*, 14.5 (2014): 111-118. (in Chinese)

PEER-REVIEWED
CONFERENCE
PROCEEDINGS

- [13] **Wei Ma**, Kendall Nowocin, Niraj Marathe, George H. Chen, "An Interpretable Produce Price Forecasting System for Small Farmers in India using Collaborative Filtering and Adaptive Nearest Neighbors", accepted by *the tenth International Conference on Information and Communication Technologies and Development (ICTDX)* and forthcoming (**Review Process**: 14% acceptance rate. Highly selective, premier conference in information and communication technologies for development (ICT4D) area. Double-blind peer review of complete manuscript prior to acceptance. There was an in-person technical program committee meeting to discuss the acceptance of the paper.)

PEER-REVIEWED
CONFERENCE
PRESENTATIONS

- [14] **Wei Ma**, Zhen (Sean) Qian. "Measuring and reducing the disequilibrium levels of dynamic networks through ridesourced vehicle data". In: *The Institute for Operations Research and the Management Sciences (INFORMS) Annual Meeting*, Phoenix, AZ, November 4-7, 2018
- [15] Xidong Pi, **Wei Ma**, Zhen (Sean) Qian. "A Data-driven Car-truck Dynamic Traffic Assignment Model". In: *The Institute for Operations Research and the Management Sciences (INFORMS) Annual Meeting*, Phoenix, AZ, November 4-7, 2018

- [16] Shayak Sengupta, Pablo Garcia, David Patoulias, Provat Saha, **Wei Ma**, Chris Tessum, Iannis Kioutsioukis, Zhen (Sean) Qian, Spyros Pandis, Inês Azevedo, Peter Adams, "High Resolution Chemical Transport Modeling of Ultrafine Particulate Matter over Pittsburgh". In: *International Aerosol Conference (IAC)*, St. Louis, MO, September 2-7, 2018
- [17] **Wei Ma** and Zhen (Sean) Qian. "A Generalized Single-level Formulation for Origin-Destination Estimation under Stochastic User Equilibrium". In: *The Transportation Research Board (TRB) 97th Annual Meeting*, Washington, D.C., January 7-11, 2018
- [18] **Wei Ma** and Zhen (Sean) Qian. "Statistical inference of probabilistic origin-destination demand using day-to-day traffic data". In: *The Institute for Operations Research and the Management Sciences (INFORMS) Annual Meeting*, Houston, TX, October 22-25, 2017
- [19] **Wei Ma** and Zhen (Sean) Qian. "Statistical inference of probabilistic origin-destination demand using day-to-day traffic data". In *INFORMS Transportation and Logistics Society, First Triennial Conference*, Chicago, IL, July 26-29, 2017
- [20] **Wei Ma** and Zhen (Sean) Qian. "On the Variance of Recurrent Traffic Flow for Statistical Traffic Assignment". In *The Transportation Research Board (TRB) 96th Annual Meeting*, Washington, D.C., January 8-12, 2017
- [21] **Wei Ma** and Zhen (Sean) Qian. "Statistical inference of probabilistic origin-destination demand using day-to-day traffic data". In *The Transportation Research Board (TRB) 96th Annual Meeting*, Washington, D.C., January 8-12, 2017
- [22] Zhen (Sean) Qian, **Wei Ma** and Cong Ma. "Dynamic network analysis and real-time traffic management for Philadelphia Metropolitan Area". In *The Mid-Atlantic Section of the Institute of Transportation Engineers (MASITE) and the Intelligent Transportation Society of Pennsylvania (ITSPA) Annual Meeting*, State College, PA, August 28-30, 2016
- [23] **Wei Ma** and Zhen (Sean) Qian. "Generalized Statistical Traffic Assignment (GESTA)". In: *The Institute for Operations Research and the Management Sciences (INFORMS) Annual Meeting*, Philadelphia, PA, November 1-4, 2015
- INVITED PRESENTATIONS
- [24] Zhen (Sean) Qian, **Wei Ma**. "Estimating multi-year 24/7 origin-destination demand using high-granular multi-source traffic data". In: *Machine Learning in Science and Engineering Conference*, June 6, 2018
- [25] **Wei Ma**, Zhen (Sean) Qian. "Measuring and reducing the disequilibrium levels of dynamic networks through ridesourced vehicle data". In: *Civil and Environmental Engineering Poster Session/Happy Hour*, May 05, 2018
- [26] Xidong Pi, **Wei Ma**, Zhen (Sean) Qian. "Data-driven Mesoscopic Network Modeling With Cars and Trucks: A Case Study in Pittsburgh". In: *Civil and Environmental Engineering Poster Session/Happy Hour*, May 05, 2018
- [27] Xidong Pi, **Wei Ma**, Shuguan Yang, Pinchao Zhang, Matthew Battifarano, Weiran Yao, Rick Grahn, Zhen (Sean) Qian, "Mobility Data Analytics Center". In: *Annual Innovation with Impact Exhibition (IWI)*, April 12, 2018
- [28] **Wei Ma**, Zhen (Sean) Qian, "Mobility Data Analytics for Decision Making in Transportation Networks". To: *Covestro*, March 21, 2018
- [29] Xidong Pi, **Wei Ma**, Shuguan Yang, Pinchao Zhang, Matthew Battifarano, Weiran Yao, Rick Grahn, Zhen (Sean) Qian, "Mobility Data Analytics Center". In: *Metro21: Smart Cities Institute Launch*, March 02, 2018
- [30] **Wei Ma**. "Travelers' Behavior Modeling, Demand Estimation and Traffic Management: a Data Perspective". In: *graduate seminar of Civil and Environmental Engineering, Carnegie Mellon University*, March 03, 2017
- [31] Xidong Pi, **Wei Ma** and Zhen (Sean) Qian. "Mobility Data Analytics Center". In: *Carnegie Mellon Traffic21/T-SET UTC Consortium Symposium and Research Showcase*, November 03, 2016

TECHNICAL
REPORTS

- [32] **Wei Ma** and Zhen (Sean) Qian, “A Reusable and Pluggable Design of Dynamic Network Models for Agile Development: MAC-POSTS”, for Mobility Data Analytics Center, Carnegie Mellon University, 2017
- [33] **Wei Ma**, Pinchao Zhang and Zhen (Sean) Qian, “Dynamic Network Analysis & Real-time Traffic Management for Philadelphia Metropolitan Area”, Report No: FHWA-PA-2016-014-CMU WO 04, for Pennsylvania Department of Transportation (PennDOT), Federal Highway Administration (FHWA) and Carnegie Mellon University’s Technologies for Safe and Efficient Transportation (T-SET), 2016
- [34] **Wei Ma** and Zhen (Sean) Qian, “Traffic impact of the Greenfield Bridge closure (AM peak)”, for Department of Public Works, the City of Pittsburgh, 2015

PROPOSAL
PREPARATIONS

- [1] Leveraging infrastructure retrofit to address interdependency trap among local economy, public health and infrastructure networks, to National Science Foundation (NSF), Leading Engineering for America’s Prosperity, Health, and Infrastructure (LEAP HI), \$1.75M requested (under review), 2018 (**Multi-disciplinary corporations:** with Professor [David Danks](#) from Department of Philosophy and Professor [Rema Padman](#) from Management Science And Healthcare Informatics)
- [2] A unified framework for real-time forecasting ride-hailing passenger demand and full traffic demand using multi-source spatio-temporal data, to DiDi Chuxing, \$94,420 requested (under second round review), 2018
- [3] Understanding and Improving Energy Efficiency of Regional Mobility Systems Leveraging System-Level Data, to Department of Energy, Advanced Vehicle Technologies Research, \$1M awarded (PI: Sean Qian), 2018 (**Corporations with public agencies:** National Renewable Energy Laboratory (NREL), The Southwestern Pennsylvania Commission (SPC), The Delaware Valley Regional Planning Commission (DVRPC), Pittsburgh Region Clean Cities (PRCC), the City of Pittsburgh)
- [4] Improving the real-time traffic management model using high-granularity multisource traffic data: methodology and case studies, to Technologies for Safe and Efficient Transportation University Transportation Center (T-SET UTC), 2018, \$100k requested
- [5] How to quantify the impact of Uber-like services to urban mobility? Large-scale network traffic flow modeling and simulation under on-demand ride sourcing services, to Technologies for Safe and Efficient Transportation University Transportation Center (T-SET UTC), \$100k requested, 2018
- [6] Estimating 24/7 Origin-destination demand using high granularity multi-source data, to DiDi Chuxing, \$100k requested, 2017
- [7] Reliability Data Guide — Procedures for Using Data in Travel Time Reliability Analyses, to Federal Highway Administration (FHWA), \$20k awarded (PI: Sean Qian), 2016
- [8] Work Zone Safety Management through Dynamic Traffic Simulation, to Technologies for Safe and Efficient Transportation University Transportation Center (T-SET UTC), \$90k awarded (PI: Sean Qian), 2016

SOFTWARE
DEVELOPMENT

- [1] Mobility Data Analytics Center - Prediction, Optimization, and Simulation toolkit for Transportation Systems (MAC-POSTS)
 - Data-driven dynamic network modeling toolkit encapsulated with state-of-art network flow, routing, traffic assignment, calibrations models
 - Developed by C++ and Python, over 10k lines
 - Website: www.mac-posts.com
- [2] Sustainable Solar Micro Cold Stores and Market Analytics tool for Indian Farmers
 - Corporated with a local startup: [CoolCrop](#)
 - Website: [India Agriculture Market Price Forecasting](#)
- [3] A Cloud-based System and Browser-based User Interfaces for Dynamic Transportation Network Simulation and Scenario Analysis
 - Developed by C++, Python and Javascript, over 5k lines
- [4] Web application: Route-Finding for Cyclists Through User-Driven Heuristics
 - Developed by Python and Javascript, over 3k lines

STUDENT
SUPERVISION

Graduate Research

- **Pengji Zhang**, Civil and Environmental Engineering, CMU, 2018
 - Web application for static traffic assignment and scenario analysis
 - Cluster analysis of probabilistic origin-destination demand using day-to-day traffic data
- **Arnav Choudhry**, School of Architecture, CMU, 2018
 - Stochastic community detection in transportation networks with crowd-sourced vehicle data

Undergraduate Research

- **Sharika Hegde**, Civil and Environmental Engineering, CMU, 2018
 - Pavement Deterioration Modeling: A Case Study in the City of Pittsburgh
- **James Crnkovich**, Civil and Environmental Engineering, CMU, 2017-2018
 - Improving Digital Route-Finding for Cyclists Through User-Driven Heuristics
- **Zach Sussman**, School of Computer Science, CMU, 2017
 - A Cloud-based System and Browser-based User Interfaces for Dynamic Transportation Network Simulation and Scenario Analysis
 - Web application for bikeability score
- **Perry Cheng** and **Noel Lau**, Civil and Environmental Engineering, CMU, 2017
 - Modeling the air pollution through dynamic traffic simulation: a case study in Pittsburgh
- **Cong (Max) Ma**, School of Computer Science, CMU, 2016
 - A Cloud-based System and Browser-based User Interfaces for Dynamic Transportation Network Simulation and Scenario Analysis

TEACHING
EXPERIENCE

Carnegie Mellon University, Pittsburgh, PA

Guest Lecturer

- 94802-B, Geographic Information Systems
 - Graduate course cross-listed in Civil and Environmental Engineering and Heinz College of Information Systems and Public Policy.
 - Lecture: “Google MyMaps and overview of open source GIS applications”.
 - Lecture: “Building a GIS application: a Digital Route-Finding application for Cyclists Through User-Driven Heuristics”.

Teaching Assistant

- TA for 94802-B, Geographic Information Systems, Department of Civil and Environmental Engineering & Heinz College (cross-listed)
 - Fall 2017 and Fall 2018
 - Responsible for 3-hour office hours, supervision of 2-hour laboratory, homework grading.
- TA for 10601, Introduction to Machine Learning, School of Computer Science
 - Spring 2017
 - Largest graduate course in CMU, over 300 students with diverse backgrounds enrolled.
 - Responsible for 2-hour office hours, recitation, Piazza Q&A and homework grading.
 - Authored and programmed multiple autograded programming assignments using Autolab.
- TA for 12750, Infrastructure management, Department of Civil and Environmental Engineering
 - Spring 2017
 - Responsible for 2-hour office hours and homework grading.
- TA for 12659, A1&A2, Special Topics: Matlab, Department of Civil and Environmental Engineering
 - Fall 2014, 2015 and 2016
 - Responsible for 3-hour office hours and homework grading.
 - Authored part of homework assignments and solutions.

- REFeree SERVICE
- *PLOS ONE*
 - *Networks and Spatial Economics*
 - *Transportmetrica A: Transport Science*
 - *COTA International Conference for Transportation Professionals*
- PROFESSIONAL MEMBERSHIPS
- Member, American Society of Civil Engineers (ASCE), 2016 - present
 - Member, Institute for Operations Research and the Management Sciences (INFORMS), 2014- present
 - Member, Transportation Research Board (TRB), 2014 - present
 - Member, Association of Tsinghua Alumni in Transportation (ATAT), 2015 - present
 - Member, Chinese Overseas Transportation Association (COTA), 2015 - present
 - Vice President, Student Association of Science and Technology(SAST), Tsinghua University, 2013
 - Member of Committee, “Green City and Future Transportation” Conference, 2013
 - Member of Lunch Awareness Project, Tsinghua University, 2012
 - Member, Propaganda Department of the Youth League Committee, Tsinghua University, 2011
- PROFESSIONAL EXPERIENCE
- Mobility Data Analytics Center**, Carnegie Mellon University, Pittsburgh, PA, USA
- Research Assistant* *Aug. 2014 - Present*
- Proposed a measure of network disequilibrium level and presented the user equilibrium routing framework using **Uber Movement data** and **DiDi Chuxing GAIA data**.
 - Proposed and implemented an efficient data-driven framework to estimate travel demand profile using high resolution traffic count and speed data on Graphics Processing Unit (GPU).
 - Developed the package “Mobility Data Analytics Center - Prediction, Optimization, and Simulation toolkit for Transportation Systems” (MAC-POSTS) for dynamic network modeling.
 - Led and completed the project “Dynamic network analysis & real-time traffic management for Philadelphia metropolitan area”.
 - Led and completed the project “traffic impact analysis of the Greenfield Bridge closure”.
- Balyasny Asset Management L.P.**, Chicago, IL, USA
- Financial Engineer Intern, Risk & Quantitative Developer* *Jun. 2017 – Aug. 2017*
- Discovered the cause of mid-term momentum using residual momentum and newly defined model momentum.
 - Proposed and implemented the model to synchronize the risk of global market based on different market opening time, provided a better estimation of the covariance matrix and increased the Sharpe ratio by 0.6.
- Singapore-MIT Alliance for Research and Technology (SMART)**, Future Mobility, Singapore
- Summer Research Intern* *Jul. 2013 – Sep. 2013*
- Designed and enhanced the convergence rate of a network calibration algorithm: W-SPSA by 17%.
 - Implemented the algorithm on Singapore’s network using real time data and improved model’s performance.
- Institute of Transportation Engineering**, Tsinghua University, Beijing, China
- Research Assisstant* *Jun. 2012 – Jun. 2014*
- Implemented and compared GLS, Kalman Filter and Stochastic Approximation for network tomography.
 - Developed a Neural Network based data fusion method to fuse traffic data, and improved the accuracy by 7.9%.
- OTHER MEETING ATTENDANCE
- General Participant**
- ASCE International Conference on Transportation & Development (ICTD 2018), Pittsburgh, PA, July 15-18, 2018
 - The Automated Vehicles Symposium 2018 (AVS 2018), San Francisco, CA, July 9-12, 2018
 - The Transportation Research Board (TRB) 95th Annual Meeting, Washington, D.C., January 10-14, 2016
 - The Transportation Research Board (TRB) 94th Annual Meeting, Washington, D.C., January 11-15, 2015

COURSE
PROJECTS

Modeling the Spatio-Temporal Evolution of Surge Multipliers with a Dynamic Conditional Random Field *Spring 2018*

- Proposed a dynamic conditional random field (DCRF) model for the spatio-temporal evolution of surge multiplier.

Streaming and Parallelized Coresets construction and its applications *Fall 2017*

- Proposed an asynchronized architecture for coresets construction to overcome the limitations of the conceptual framework.
- Implemented the proposed framework by Message Passing Interface (MPI) C++ and validated the framework with different coresets construction methods.

Estimating Low Dimensional Structure from Multivariate Data — From Filament to Ridge *Spring 2016*

- Explored different filament estimation methods and analysed the performance using noisy point clouds.
- Discussed the ridge estimation for high dimensional data cloud with Gaussian noise.

History-dependent adaptive SGD methods under asynchronized distributed setting *Spring 2015*

- Reformulated AdaGrad and AdaDelta to adapt asynchronized distributed setting and proved its convergence.
- Implemented the asynchronized distributed setting and SGD, AdaGrad, AdaDelta by OpenMPI.

Social circle recommendation System *Fall 2014*

- Implemented and compared different clustering algorithms on grouping users' friends.
- Used lasso penalized logistic regression to help users set up groups for different friends; achieved 81.98% accuracy.

RcStudio – Online Reinforced Concrete Design System *Spring 2013*

- Developed an artificial intelligence Q&A robot as a component of the system.

TECHNICAL
SKILLS

Programming Languages:

- *High performance computing:* C/C++, Java
- *Data science:* Python, MATLAB, R, SQL
- *Web application:* JavaScript, CSS, HTML

Library & API

- *Data science:* Networkx, Pandas, Plotly
- *Parallel computing:* MPI, Boost, Hadoop, PIG, Spark
- *Web application:* Django, Tornado, peewee
- *Deep learning:* TensorFlow, PyTorch

Tools:

- *Cloud computing:* AWS, Git, Vim, Bash
- *Databases:* MySQL, PostgreSQL

Language Competencies:

- Mandarin, English, Japanese